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The temporal evolution of trace metals in sediment: are we on track to achieve clean and healthy seas?

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Abstract

Trace elements (TEs) frequently contaminate coastal and estuarine sediments, however, no extensive spatial and temporal scale assessment has confirmed if improvements for inputs have reduced sediment concentrations. By mining UK datasets for hundreds of Channel (UK) sites we assess sediment concentrations of As, Cd, Cr, Cu, Fe, Hg, Ni, Pb and Zn and use indices (PI, TEPI and I_{geo}) to assess the 30 year evolution of TE pollution, generating current site trajectories. For the Channel, TEPI and PI show significant reductions in the 1980s then incremental improvements followed by a distinct increase for 2010-14. Temporal I_{geo} trends show moderate pollution for Cd and Hg, but remaining stable after early reductions. This stability is also present for As, Pb and Zn, although the I_{geo} scores reflect low contamination. I_{geo} scores are low for Ni, Fe and Cr, but increasing towards the moderate pollution threshold for Ni. A moderate pollution I_{geo} score for Cu has also been increasing steadily since the mid-1990s. Some regional I_{geo} scores are increasing, however, significant increasing trends for sites are not ubiquitous. Conversely, minimal temporal change masks some significant site-specific increases and decreases. We, therefore, strongly recommend that sufficient sentinel sites are embedded within planned coastal observation networks. Our data confirm that reducing inputs *does* improve sediment pollution levels (e.g. Pb and Hg), but stable I_{geo} scores require continued global and local input vigilance. Increasing I_{geo} scores require the source identification for Ni and Fe, but this is a priority for Cu due to its elevated I_{geo} score and potent marine toxicity. Analysis indicates substantial 'hidden' inputs from ship emissions (Ni, Cu and Zn) and anti-fouling paints (Cu and Zn) with the predicted expansion of the commercial fleet and increases in the number of vessels adopting scrubber technology likely to increase these further.

Keywords

antifouling, shipping, benthic, heavy metal